resonance peaks of metallic CNTs disappear in the supernatant isolated from the dispersion by centrifugation.

[0190] Referring to FIG. **6**, which illustrates RBM spectra in a region of 180 cm^{-1} to 285 cm^{-1} when excited at 1.94 eV (633 nm), resonance peaks of metallic CNTs and semiconducting CNTs appear in the dispersion before centrifugation, whereas the resonance peaks of metallic CNTs disappear in the supernatant isolated from the dispersion by centrifugation.

[0191] The resonance peaks of semiconducting CNTs mostly remain in a region of 240 cm^{-1} to 285 cm^{-1} in which resonance peaks of nonmetallic CNTs normally appear.

[0192] Referring to FIG. **7**, which illustrates RBM spectra in a region of 180 cm^{-1} to 285 cm^{-1} when excited at 1.59 eV (785 nm), resonance peaks of only semiconducting CNTs appear in the dispersion before centrifugation, whereas the resonance peaks of semiconducting CNTs remain in the supernatant isolated from the dispersion by centrifugation.

[0193] Based on this result, it is understood that the supernatant obtained after centrifugation include semiconducting single-walled CNTs with a high yield such as about 100%, excluding the metallic CNTs, which were almost completely removed from the supernatant by the centrifugation.

[0194] Evaluation Comparison of Hole Mobility and on/Off Current Ratio of TFTs

[0195] A TFT was manufactured with a Pt source electrode, a Ti drain electrode, and a gate electrode (heavily n-doped Si substrate), and a SiO_2 dielectric layer (having a thickness of 300 nm).

[0196] A surface of the SiO_2 insulating layer was modified to have a self-assembled monolayer (SAM) including an amine terminal group. CNTs, which were randomly disposed between the source electrode and the drain electrode, had an average length of 1.0 μm±0.1 μm, as observed by scanning electron microscopy (SEM). The CNTs were used to form a channel between the source electrode and the drain electrode. The CNT channel included less than fifty (>50) CNTs per mm^2 on average, and had a thickness of about 2.3 nm.

[0197] Referring to FIGS. **9** and **10**, based on the voltage levels of the gate electrode and the current levels of the drain electrode, the TFT is found to have a hole mobility of 10 cm^2/Vs or greater, and an on/off current ratio of 10^6 or greater.

[0198] As described above, according to example embodiments, a method of selective separation of semiconducting CNTs enables semiconducting CNTs to be separated easily with a high yield, and an electronic device including semiconducting CNTs separated by using the method may have improved electrical characteristics.

[0199] Solar Cells

[0200] FIGS. **11**A and **11**B are schematic views of solar cells according to example embodiments.

[0201] Referring to FIG. **11**A, a solar cell **100** according to example embodiments may include a substrate **10**, lower electrode **20**, photoactive layer **50**, and an upper electrode **60** sequentially stacked. The material of the substrate **10** may include one of non-conductive polymers, silicon, glass, fused silica, quartz, plastics, polydimethylsiloxane (PDMS), and combinations thereof, but example embodiments are not limited thereto. The lower electrode **20** and upper electrode **60** each may include at least one transparent conductive oxide material, such as zinc oxide, tin oxide, indium tin oxide, and the like, but example embodiments are not limited thereto. The material and/or materials of the lower electrode **20** and the upper electrode **60** may be the same or different. The photoactive layer **50** includes a n-type layer **30** and a p-type layer **40**. The p-type layer **40** may include a dispersion containing semiconducting carbon nanotubes according to example embodiments. The semiconducting CNTs may be used as a charge generation in solar cells. Further, the semiconducting CNTs may be used to facilitate a charge transport, according to the characteristics of the CNTs. The polythiophene derivative can be used as an electron donor.

[0202] Referring FIG. **11**B, a solar cell **200** according to example embodiments may be similar to the solar cell **100** in FIG. **11**A, except the photoactive layer **90** includes a mixture of p-type material **80** and n-type material **70**. The discussion of like structural elements between solar cells **100** and **200** will be omitted. The p-type layer **80** may include a dispersion containing semiconducting carbon nanotubes according to example embodiments.

[0203] While some example embodiments have been particularly shown and described, it will be understood by one of ordinary skill in the art that variations in form and detail may be made therein without departing from the spirit and scope of the claims.

1.-**22**. (canceled)

23. An electronic device comprising semiconducting carbon nanotubes; and

a polythiophene derivative,

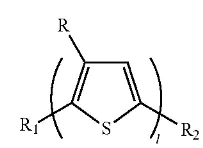
wherein the polythiophene derivative includes a thiophene ring and a hydrocarbon sidechain linked to the thiophene ring,

the hydrocarbon sidechain including an alkyl group containing a carbon number of 7 or greater, and

the hydrocarbon sidechain being regioregularly arranged.

24. The electronic device of claim **23**, wherein the polythiophene derivative is represented by Formula 1 below:

Formula 1



wherein R is a C7 to C50 alkyl group;

R_1 and R_2 are each independently one of hydrogen, halogen, methyl, and halomethyl; and

1 is an integer from 1 to 40,000.

25. The electronic device of claim **23**, wherein the polythiophene derivative is represented by one of Formulae 2, 3, and 4, below:

Formula 2